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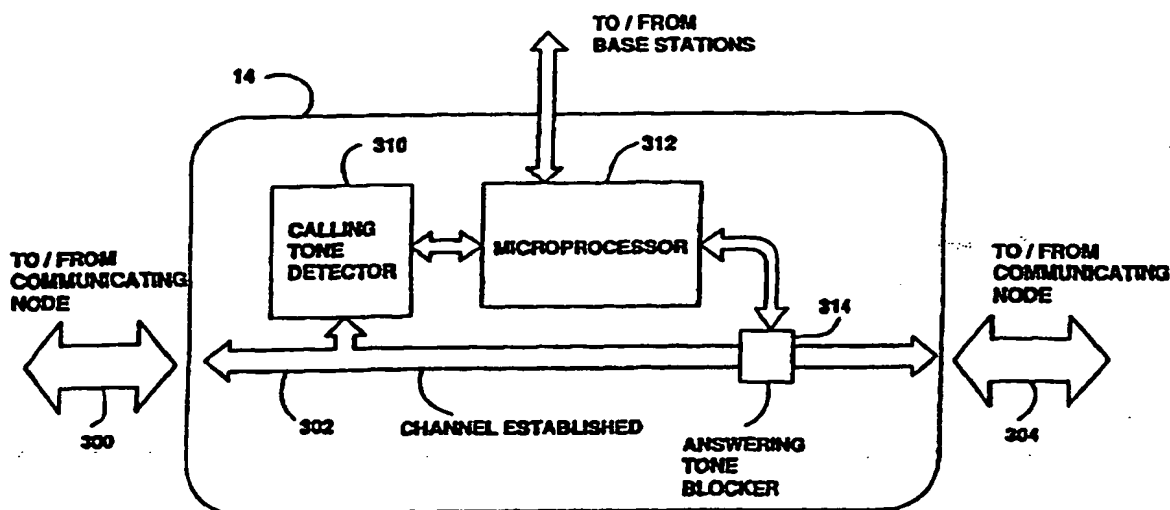


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(54) Title: CDMA COMMUNICATION SYSTEM WHICH SELECTIVELY SUPPRESSES DATA TRANSMISSIONS DURING ESTABLISHMENT OF A COMMUNICATION CHANNEL



(57) Abstract

A CDMA communication system which prevents the transmission of data between communicating nodes until the data communication rate required by the communicating nodes has been completely established throughout the system selectively suppresses (314) the confirmation tone that a receiving node sends to an originating node. The transmission of voice, facsimile or modem data is prevented until the communication path has been established at the desired communication rate. This permits the system to reliably transport encoded data at a plurality of data rates across a telecommunication system which may lack precise synchronization.

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**CDMA COMMUNICATION SYSTEM WHICH
SELECTIVELY SUPPRESSES DATA TRANSMISSIONS
DURING ESTABLISHMENT OF A COMMUNICATION CHANNEL**

BACKGROUND OF THE INVENTION

5 Field of the Invention

 This invention generally relates to wireless communication systems. More particularly, the invention relates to a wireless digital CDMA communication system that selectively adjusts the data transmission rate depending upon the bandwidth required by the communication without the loss of data during the transmission rate adjustment.

Description of Related Art

 The telecommunications industry has recently experienced strong growth in the use of wireless technology including cellular, satellite and microwave communications. As the popularity and use of wireless communication systems has increased, the finite bandwidth allocated to each type of wireless communication has become increasingly valuable. Since it is unlikely that additional bandwidth to support user growth will be allocated for existing applications, many of the recent advances in telecommunication hardware and software have been directed toward increasing the transmission rate of data while utilizing the same or a decreased bandwidth.

 One of the problems associated with wireless communication of data is that many different types of communicating nodes are currently in use including computers, facsimile machines, automatic calling and answering equipment and other types of data networks. These nodes may be able to communicate at a plurality of different data rates and must

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be properly synchronized to avoid losing data during the establishment or maintenance of a communication.

The establishment and synchronization of communications is currently performed using a variety of different techniques. For example, the system disclosed in U.S. Patent No. 4,384,307 (Kuzmik et al.) includes a communication adapter for interfacing a transceiver to a communication line. The system requires bit level manipulation of data to properly synchronize two communicating nodes. Reformatting of data using this technique is computationally expensive and prone to errors.

Another type of system is disclosed in U.S. Patent No. 4,583,124 (Tsuji et al.) which permits two nodes to quickly establish synchronization at a desired communication speed by storing information concerning each communicating node in memory. However, requiring an originating node to store information about each receiving node is impractical given today's communication environment.

Accordingly, there is a need for a simple and effective technique for switching the data transmission rate of a communication network to the required rate while preserving the integrity of the data transmitted between two communicating nodes.

SUMMARY OF THE INVENTION

The present invention is a CDMA communication system which prevents the transmission of data between communicating nodes until the data communication rate required by the

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communicating nodes has been completely established throughout the system. The system selectively suppresses the confirmation tone that a receiving node sends to an originating node. Accordingly, the transmission of voice, facsimile or modem data is prevented until the communication path has been established at the desired communication rate. This permits the system to reliably transport encoded data at a plurality of data rates across a telecommunication system which may lack precise synchronization.

Accordingly, it is an object of the present invention to provide a system and method for reliably transmitting encoded data by preventing communication of data until the communication system has achieved the data transmission rate required by communicating nodes.

Other objects and advantages of the present invention will become apparent after reading the description of a presently preferred embodiment.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a schematic overview of a code division multiple access communication system in accordance with the present invention;

Figure 2 is a block diagram of the communication system of Figure 1 connected to originating and terminating nodes;

Figure 3 is a flow diagram of the establishment of a communication channel between originating and terminating nodes in accordance with the prior art;

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Figure 4 is a flow diagram of the establishment of a communication channel between originating and terminating nodes in accordance with the present invention; and

Figure 5 is a block diagram of a base station in accordance with the teachings of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred embodiment will be described with reference to the drawing figures where identical numerals represent similar elements throughout.

A communication network 10 embodying the present invention is shown in Figure 1. The communication network 10 generally comprises one or more base stations 14, each of which is in wireless communication with a plurality of subscriber units 16, which may be fixed or mobile. Each subscriber unit 16 communicates with either the closest base station 14 or the base station 14 which provides the strongest communication signal. The base stations 14 also communicate with a base station controller 20 which coordinates communications among the base stations 14. The communication network 10 may also be connected to a public switched telephone network (PSTN) 22, wherein the base station controller 20 also coordinates communications between the base stations 14 and the PSTN 22. Preferably, each base station 14 communicates with the base station controller 20 over a wireless link. Although the link between the base stations 14 and the base station controller 20 is shown as a wireless link, it should be apparent to those skilled in the art that

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a land line between the base stations 14 and the base station controller 20 may be provided. This is particularly applicable when a base station 14 is in close proximity to the base station controller 20.

5 The base station controller 20 performs several functions. Primarily, the base station controller 20 provides all of the overhead, administrative and maintenance (OA&M) signaling associated with establishing and maintaining all of wireless communications between the subscriber units 16, the
10 base stations 14, and the base station controller 20. The base station controller 20 also provides an interface between the wireless communication system 10 and the PSTN 22. This interface includes multiplexing and demultiplexing of a plurality of communication signals that enter and leave the
15 system 10 via the base station controller 20. Although the wireless communication system 10 is shown employing antennas to transmit RF signals, one skilled in the art should recognize that communications may be accomplished by microwave satellite uplinks.

20 Referring to Figure 2, the communication system 10 is generally connected to originating nodes 40 and terminating nodes 44. In order to conserve as much bandwidth as possible, the communication system 10 selectively allots the bandwidth required for supporting the data transmission rate required
25 by the originating and terminating nodes 40, 44. In this manner, the system 10 ensures that the bandwidth is utilized efficiently. Voiced communications may be effectively transmitted across a 32 Kbs adaptive pulse code modulation

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(ADPCM) channel. However, a high speed fax or data modem signal requires at least a 64 Kbs pulse code modulation (PCM) signal to reliably transmit the communication. Many other types of modulation techniques and data transmission rates may also be utilized by originating and terminating nodes 40, 44. The system 10 must be able to effectively allocate bandwidth and dynamically switch between these data communication rates and modulation schemes on demand.

The communication system 10 provides a communication link between the originating and terminating nodes 40, 44. The originating and terminating nodes 40, 44 may comprise computers, facsimile machines, automatic calling and answering equipment, data networks or any combination of this equipment. For robust communication of data it is imperative to ensure that the communication system 10 switches to the data transmission rate required by the communicating nodes 40, 44 prior to the transmission of any data.

Referring to Figure 3, the typical procedure for establishing communications between originating nodes 40 and terminating nodes is shown. The originating node 40 periodically transmits a calling tone (step 100) which indicates that a data communication, (not a voice communication), is to be transmitted. The calling tone which is sent from the originating node 40 to the terminating node 44 is detected by the terminating node 44 (step 102) which initiates several actions. First, the terminating node 44 prepares to send a data communication (step 104). Next, the terminating node 44 transmits an answering tone (step 106) to

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the originating node 40 to confirm that the terminating node 44 has received the calling tone. Upon receipt of the answering tone (step 108), the originating node 40 begins the transmission of data (step 110), which is received by the terminating node 44 (step 112). With the communication link established at the data transmission rate, the originating and terminating 40, 44 nodes transmit and receive data until termination of the communication.

One problem with this process is that the transmission rate of the communication system 10 is transparent to both the communicating and terminating nodes 40, 44. Modification of the transmission rate from a low rate (that supports voice communication) to a high rate (that supports encoded data communication) ensures that data will be reliably and quickly transmitted over a communication channel. However, the new transmission rate must be completely established throughout the communication system 10 to prevent false interpretation of tones transmitted by the originating node 40. The originating node 40 may begin transmission of data at a high rate before the system 10 has fully switched from 32 Kbs ADPCM to 64 Kbs PCM resulting in loss of data.

In order to obviate tone misinterpretation and to prevent the resulting erroneous operation of the originating or transmitting nodes 40, 44, the present invention blocks the transmission of the confirming tone to the originating node 40 until the new data transmission rate has been completely established throughout the communication system 10. This prevents the reception of the answering tone at the

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transmitting node 40 and ensures the reliable transportation of encoded data at a higher rate across a communication system 10 which lacks the precise synchronization which would otherwise be required.

5 The operation of the system 10 of the present invention will be explained with reference to Figure 4. The communication system 10 facilitates communications between an originating node 40 and a terminating node 44. As shown, the actions of the originating node 40 (steps 202, 212 and 214)
10 and the actions of the terminating node 44 (steps 206, 207, 208 and 218) are the same as in Figure 3. The operation of the communication system 10 is transparent to both the originating node 40 and the terminating node 44.

15 In operation, the originating node 40 periodically transmits a calling tone (step 202) which indicates a data communication. The communication system 10 performs several actions in response to receipt of the calling tone (step 204). First, the calling tone is received at 32 Kbs ADPCM which is the standard communication setting for voice communications.
20 The system 10 detects the calling tone and initiates a switch to 64 Kbs PCM in order to handle the high-speed data transmission. This switch must be implemented by the base station 14, the subscriber unit 16 and the base station controller 20. Although the system 10 immediately begins the
25 switching over to the new data transmission rate, the process takes approximately 1500 msec to implement. Accordingly, the system 10 transmits the calling tone to the terminating node 44 at 32 Kbs ADPCM.

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The terminating node 44 detects the calling tone (step 206) and prepares to send a data communication (step 207). The terminating node 44 subsequently transmits the answering tone (step 208) which, when received by the originating node, will cause the originating node 40 to begin transmission of data.

The communication system 10 receives the answering tone from the terminating node 44. However, the system 10 does not forward the answering tone to the originating node 40 until the switch to 64 Kbs PCM has been established throughout the system 10. After the system 10 has confirmed that the switch to 64 Kbs PCM has been achieved, it permits the answering tone to pass through to the originating node 40, which receives the tone (step 212). In response to the answering tone, the originating node 40 begins transmission of data (step 214). The system 10 receives the data and begins transmission of data at the new data transmission rate (64 Kbs PCM) (step 216) to the terminating node 44 which receives the data (step 218). Since the communication channel has been established, the originating and terminating nodes 40, 44 continue to communicate over the system 10 in this manner (steps 214, 216 and 218) until the communication is terminated.

Referring to Figure 5, a more detailed block diagram of the base station controller 20 is shown. The base station controller 20 controls at least a portion of the communication link between two communicating nodes 40, 44. This link comprises the transmission path 300 from a first communicating node to the base station controller 20, the transmission path

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302 within the base station controller 20, and the transmission path 304 from the base station controller 20 to the second communicating node. The transmission paths 300, 304 to and from the base station controller 20 may include a plurality of base stations 14 and subscriber units 16 which are controlled by the base station controller 20.

It should be appreciated by those of skill in the art that the establishment of a communication channel between communicating nodes 40, 44 is a complex procedure involving a plurality of tasks performed by the base station 14, the subscriber unit 16 and the base station controller 20. A detailed description of the entire procedure is outside the scope of the present invention. Accordingly, only those portions of the procedure for establishment of a communication channel relevant to the present invention will be described hereinafter.

The communications between an originating node 40 and a terminating node 44 are transmitted over a virtual channel as is well known by those of skill in the art. Since the entire spectrum is used by the CDMA communication system 10, communications from the originating node 40 to the terminating node 44 are transmitted over the same frequency band as communications from the terminating node 44 to the originating node 40. After the virtual channel has been established, the originating and terminating nodes 40, 44 may freely communicate.

The base station controller 20 includes a calling tone detector 310, a microprocessor 312 and an answering tone

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blocker 314. The calling tone detector 310 monitors the communication channel which has been established in order to detect the calling tone. When a calling tone is transmitted from an originating node 40, the calling tone detector 310
5 detects the calling tone, which causes the base station controller 20 to initiate the switch to a higher data transmission rate. The microprocessor 312 subsequently informs any other base stations 14 or subscriber units 16 through which the communication is to be routed (hereinafter
10 called communicating equipment) to initiate the switch to the higher data transmission rate.

The microprocessor 312 activates the answering tone blocker 314 which will prevent the answering tone from being transmitted through the system 10. Each piece of
15 communicating equipment 14, 16, 20 transmits an acknowledgment to the microprocessor 312 of the base station controller 20 when the higher data transmission rate has been achieved. The microprocessor 312 subsequently deactivates the answering tone blocker 314 which permits the answering tone to be forwarded
20 to the originating node 40. The communicating nodes 40, 44 commence data transmission over the communication system 10 at the higher data transmission rate.

Although the invention has been described in part by making detailed reference to the preferred embodiment, such
25 detail is intended to be instructive rather than restrictive. For example, the functions performed by the base station controller 20 shown in **Figur 5** may, in an alternative embodiment, be performed by a base station 14 coupled with

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either the originating or terminating nodes 40. The functions of a base station 14 may also be combined with the base station controller 20, to form a master base station. Additionally, different data rates and modulation schemes may be employed. It will be appreciated by those skilled in the art that many variations may be made in the structure and mode of operation without departing from the spirit and scope of the invention as disclosed in the teachings herein.

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What is claimed is:

1. A system for suppressing selective communications during bearer rate modification in a communication network, the system comprising:

5 means for establishing a communication channel between first and second communicating nodes at a first data rate;

means for detecting a transmission from said first node on said channel;

means for determining whether said transmission requires a change in data rates to a second data rate;

10 switch means, responsive to said determining means, for switching said communication channel to said second data rate; and

blocking means, responsive to said determining means, for blocking transmissions from said second node until said second
15 data rate has been established.

2. The system of claim 1 wherein said detecting means detects tones at a plurality of selective frequencies and said tones initiate a change to said second data rate.

3. The system of claim 2 wherein said switch means switches said first data rate to said second, higher data rate.

4. The system of claim 3 wherein said first data rate is 32 kb/s and said second data rate is 64 kb/s.

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5. The system of claim 4 wherein said first data rate employs pulse code modulation and said second data rate employs adaptive pulse code modulation.

6. The system of claim 1 wherein said switch means is responsive to said determining means to switch said established channel to one of a plurality of alternative channels, depending upon the required data rate and modulation type.

7. A communication system for selectively adjusting data transmission rates without the loss of data during the transmission rate adjustment, the system comprising:

means for establishing a communication channel between
5 an originating node and a terminating node, said channel comprising a first communication path from said originating node to said terminating node and a second communication path from said terminating node to said originating node;

10 means for monitoring said first communication path for a signal, said signal indicating the request for a transmission rate adjustment;

adjustment means, responsive to said detection means, for adjusting the transmission rate of said communication channel;
and

15 suppression means, responsive to said detection means, for suppressing communications on said second communication path until the desired communication rate is established.

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8. The system of claim 7 wherein said monitoring means detects signals having selective frequencies indicating a request for an increased data transmission rate.

9. The system of claim 8 wherein said adjustment means switches said communication channel to a second communication channel having said higher data transmission rate.

10. The system of claim 9 wherein said communication channel has a data rate of 32 kb/s and said second communication channel has a data rate of 64 kb/s.

11. The system of claim 10 wherein said communication channel uses pulse code modulation and said second communication channel uses adaptive pulse code modulation.

12. The system of claim 11 wherein said signal indicates the data rate and modulation type required and said adjustment means is responsive to said monitoring means to switch said channel to one of a plurality of alternative channels,
5 depending upon the required data rate and modulation.

13. A method for modifying the data transmission rate of a communication system comprising:

receiving a first communication from an originating node at a first data communication rate;

5 detecting a request for a modification of said data communication rate;

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initiating a modification to said requested data communication rate;

transmitting said first communication at said first data rate to a terminating node;

receiving a second communication from said terminating node;

suppressing said answering tone until said modification is completed;

completing said modification; and

transmitting said second communication to said originating node.

14. A system for suppressing selective communications during channel modification in a communication network, the system comprising:

means for establishing a first duplex communication channel between first and second communicating nodes comprising a transmit (Tx) portion and a receive (Rx) portion; said channel having a first data communication rate and modulation type;

means for detecting a transmission from said first node on said Tx portion;

means for determining whether said transmission requires a change to a second duplex communication channel having a second data communication rate and modulation type;

switch means, responsive to said determining means, for switching said first communication channel to said second communication channel; and

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blocking means, responsive to said determining means, for blocking transmissions on said Rx portion until said second communication channel is established.

15. The system of claim 1 wherein said detecting means detects selective transmitted frequencies on said Tx portion which indicate a requirement for a change to said second communication channel.

16. The system of claim 2 wherein said second communication channel has a faster data rate than said first communication rate.

17. The system of claim 3 wherein said first data communication rate is 32 kb/s and said second data communication rate is 64 kb/s.

18. The system of claim 4 wherein said first data communication channel uses pulse code modulation and said second communication channel uses adaptive pulse code modulation.

19. The system of claim 1 wherein said switch means is responsive to said determining means to switch said established channel to one of a plurality of alternative channels, depending upon the requested data rate and modulation.

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20. A system for suppressing selective communications during bearer rate modification in a communication network, the system comprising:

means for establishing a communication channel between
5 first and second communicating entities;

means for detecting a transmission from said first entity
over said channel;

determining means responsive to said detecting means,
determining if a new communication channel is required;

10 switch means, responsive to said determining means, for
switching over said communication channel to a communication
channel;

blocking means, responsive to said determining means, for
blocking transmissions from said second entity to said first
15 entity until said switch over is completed.

21. A method for modifying the data transmission rate of a
communication system comprising:

receiving a first communication from an originating node
at a first data communication rate;

5 detecting the data rate and type of modulation required
to support said first communication;

initiating a modification to a second communication
channel having said data rate and type of modulation;

transmitting said first communication at said first data
10 rate to a terminating node;

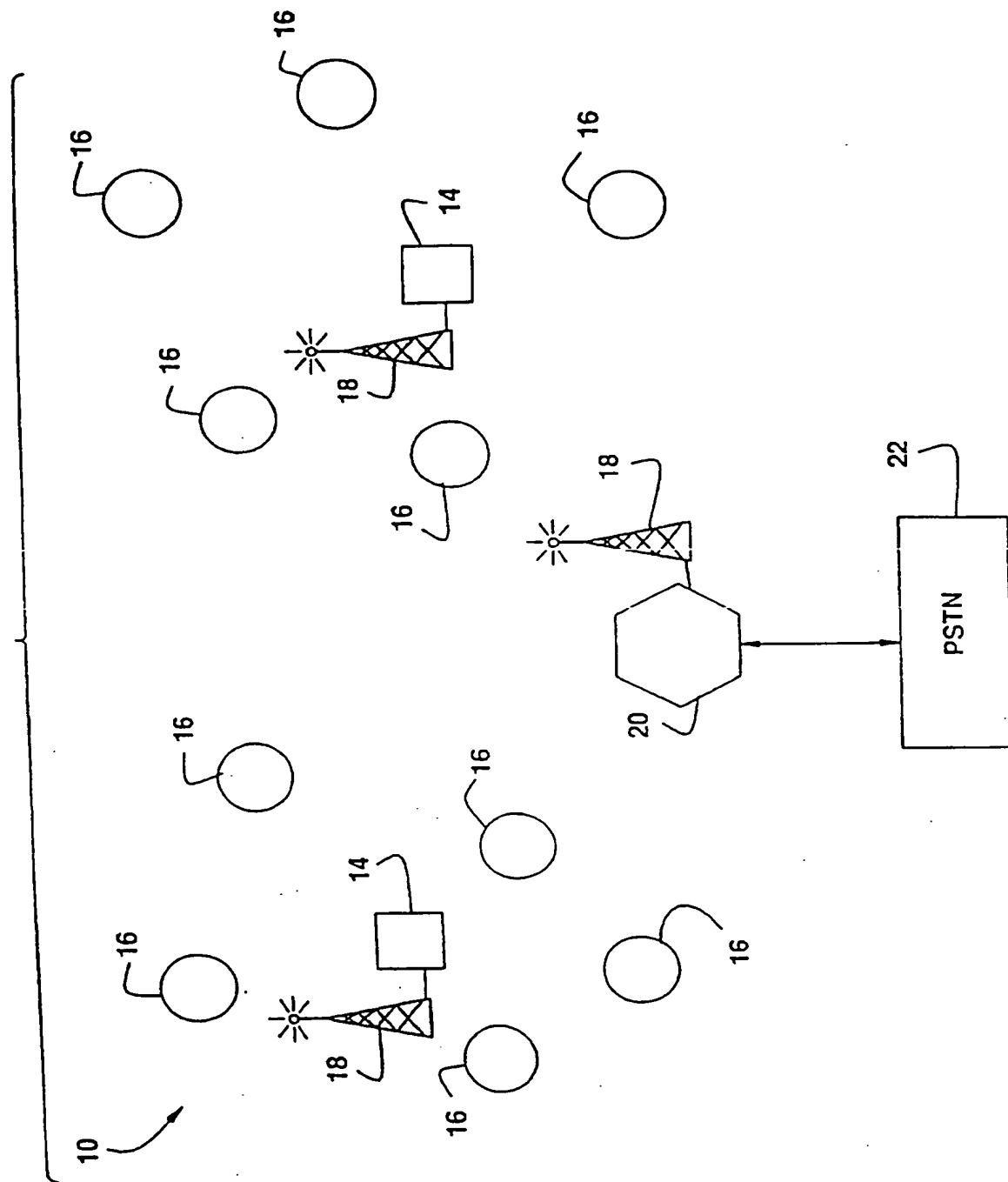
receiving a second communication from said terminating
node;

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suppressing said second communication until said
modification is completed; and

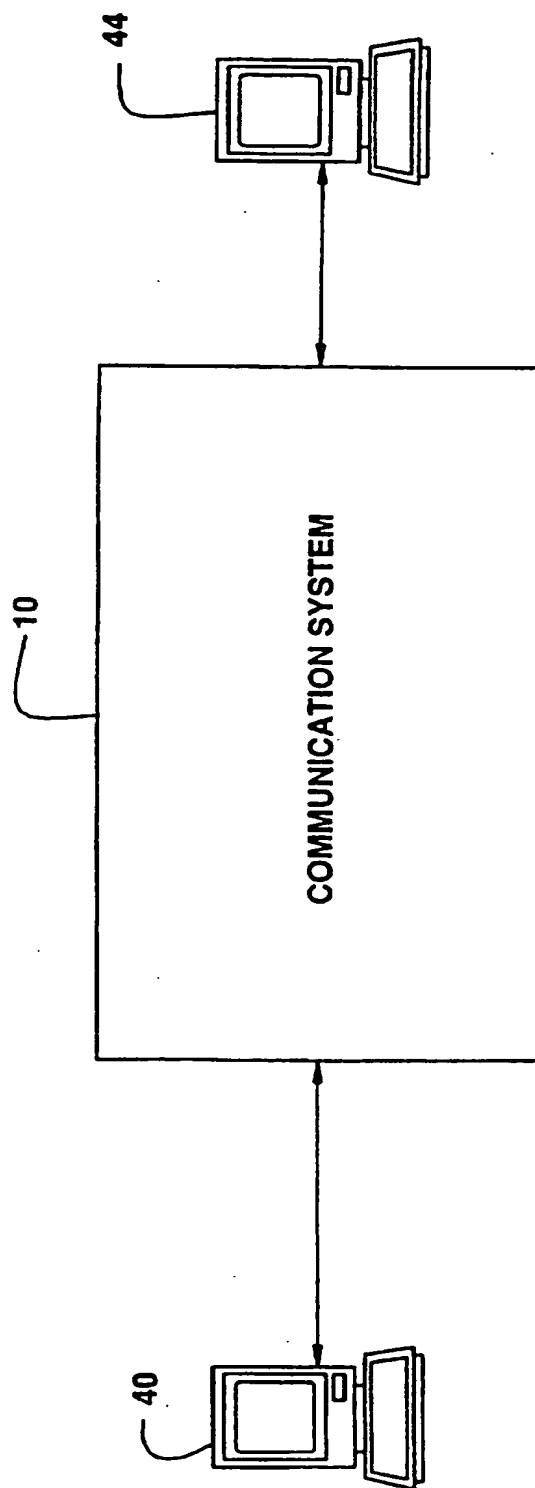
15 transmitting said second communication to said
originating node.

FIG.1



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FIG.2



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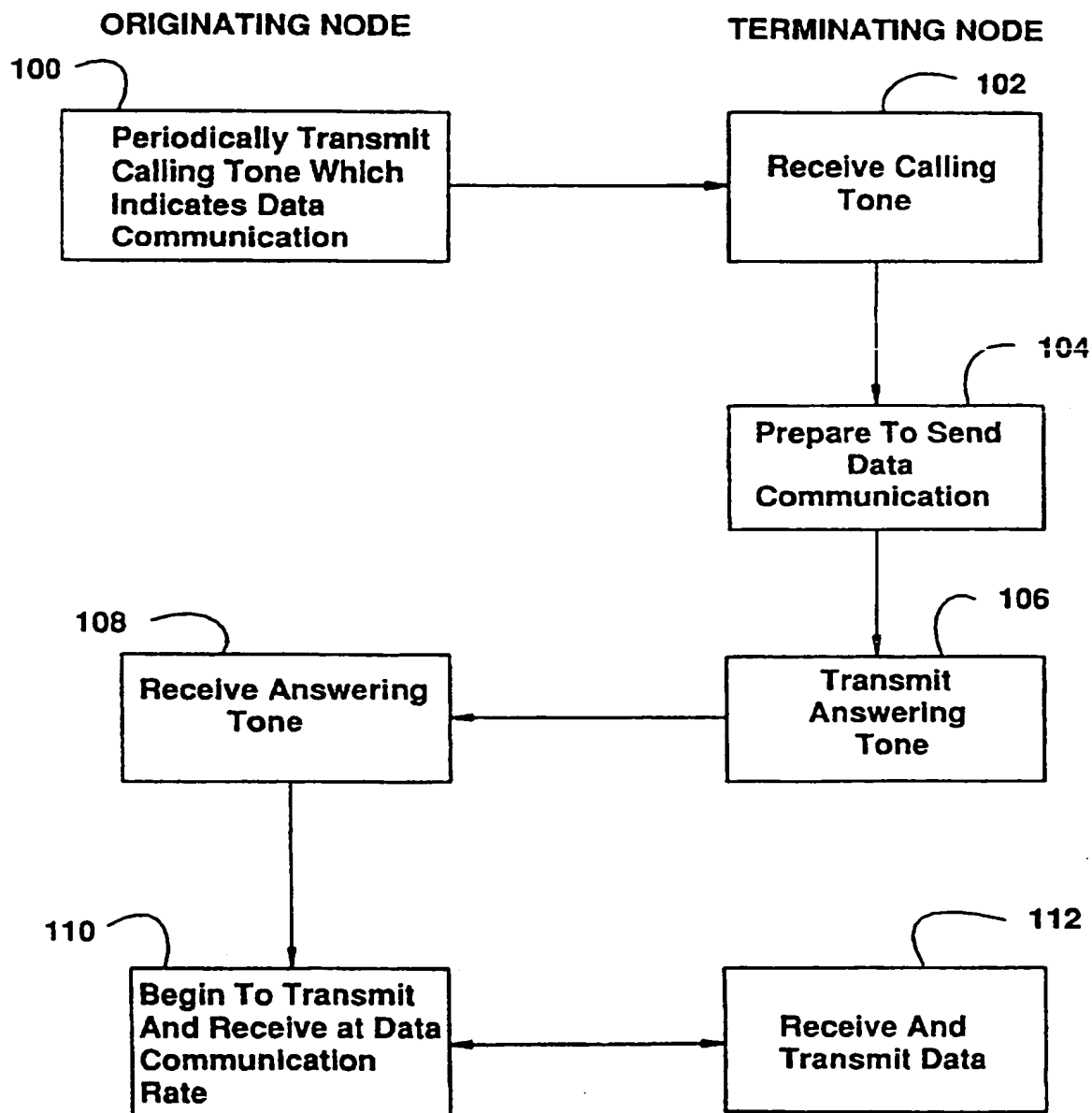
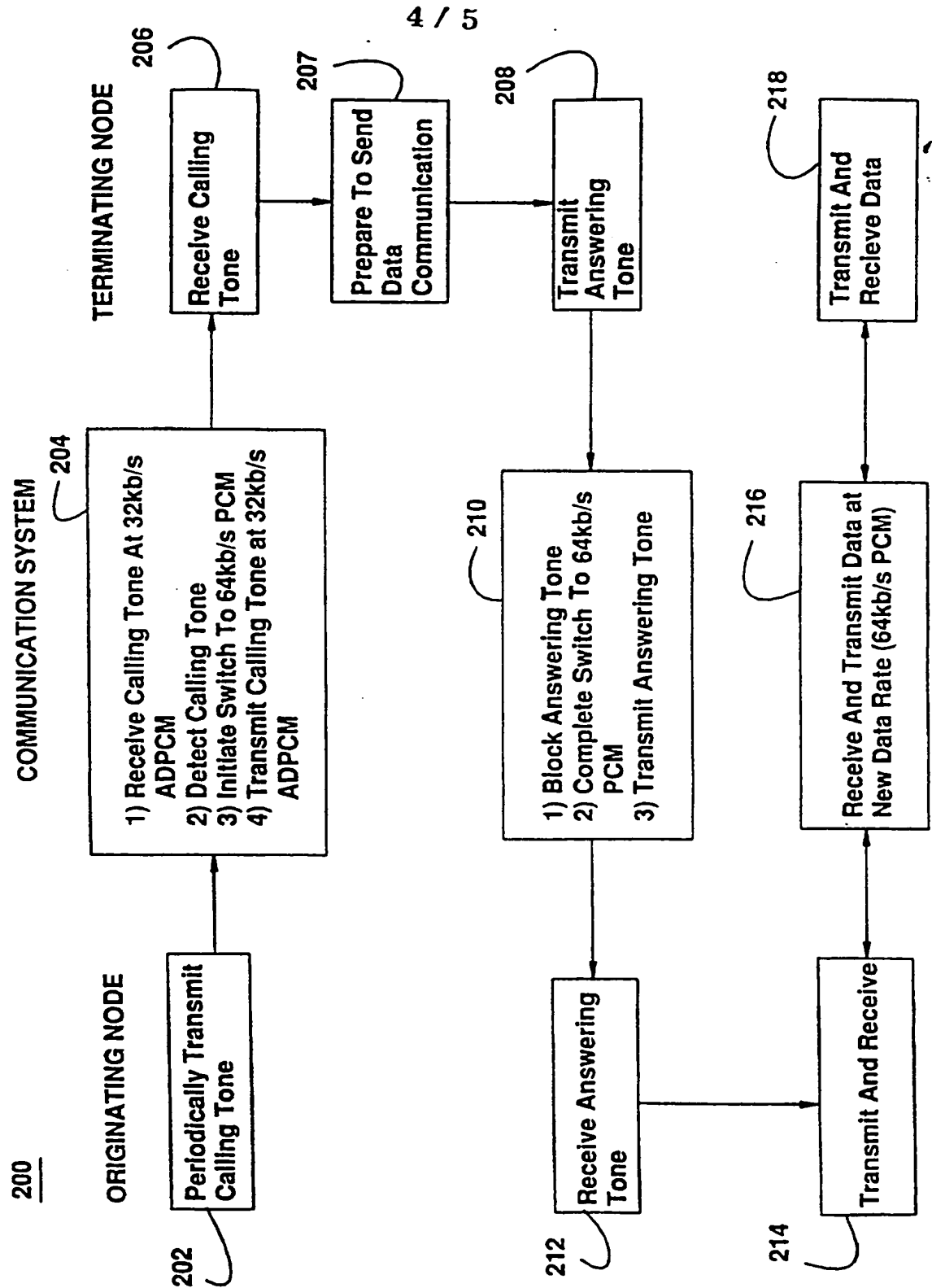
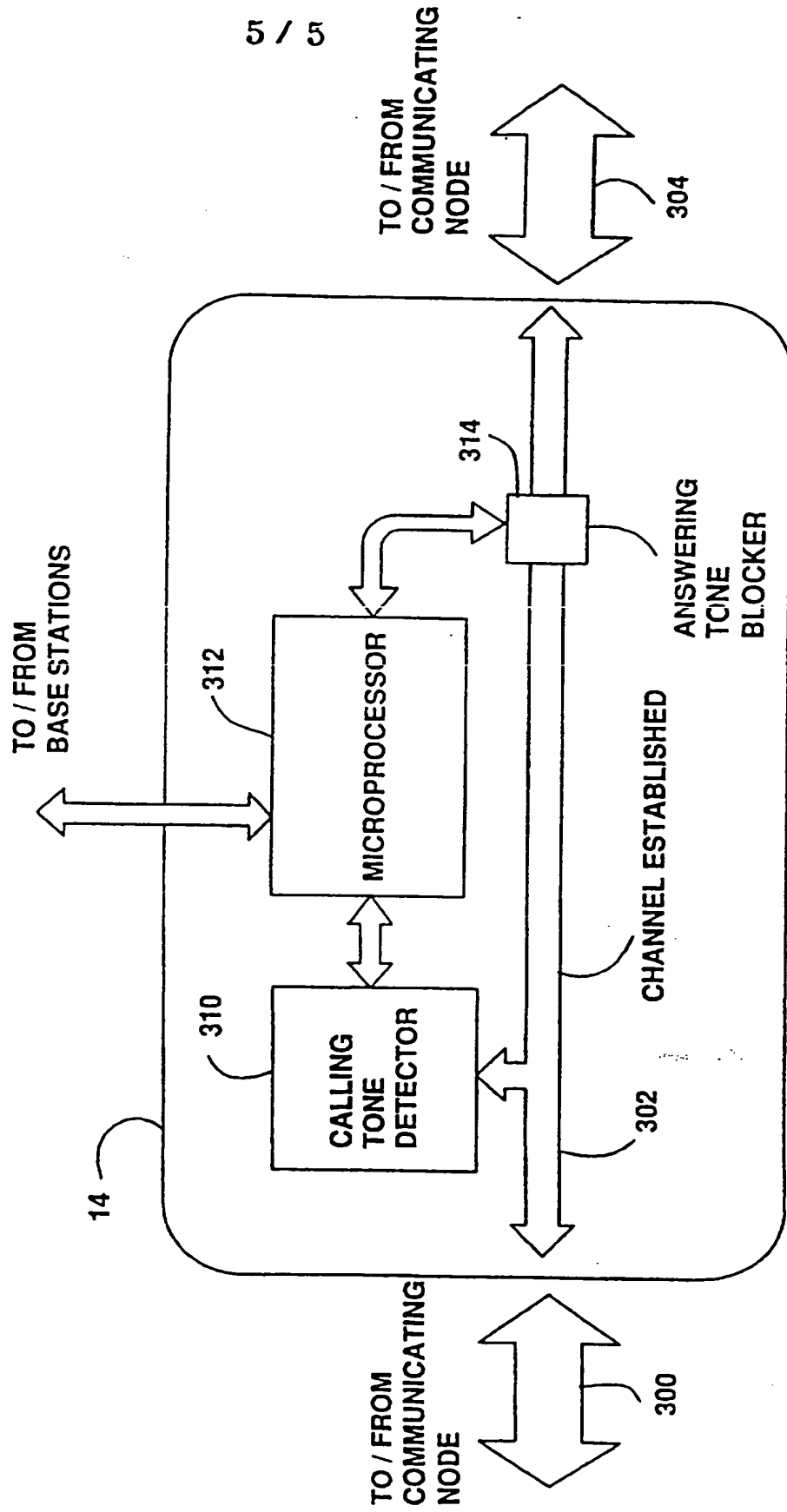
FIG.3
PRIOR ART

FIG. 4



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FIG.5



INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/US 97/10760

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04L5/14 H04N1/333

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04L H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 700 820 A (BLASBALG ET AL) 24 October 1972	1,13,20, 21
Y	see column 5, line 13 - line 37 see column 27, line 61 - line 66	2-12, 14-19
Y	--- US 5 199 061 A (KIM) 30 March 1993 see column 3, line 18 - line 19 see column 4, line 30 - line 40 see claim 1 --- -/--	2-5, 8-12, 15-18

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☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/US 97/10760

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

information on patent family members

International Application No

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